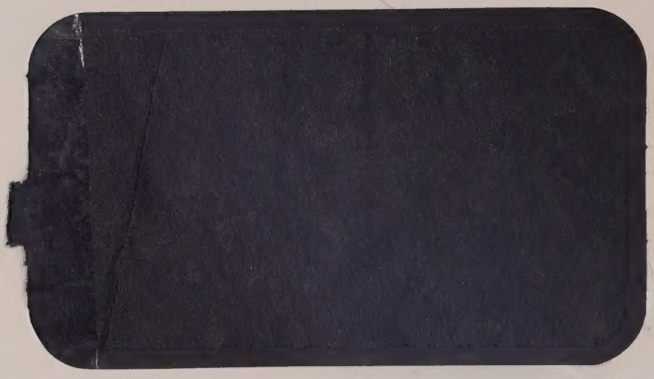
POWER SUPPLY
MODEL QRE 3-300-M3

MP MASTER
MA25509

Sorensen
POWER SUPPLIES



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POWER SUPPLY
MODEL QRE 3-300-M3

RAYTHEON
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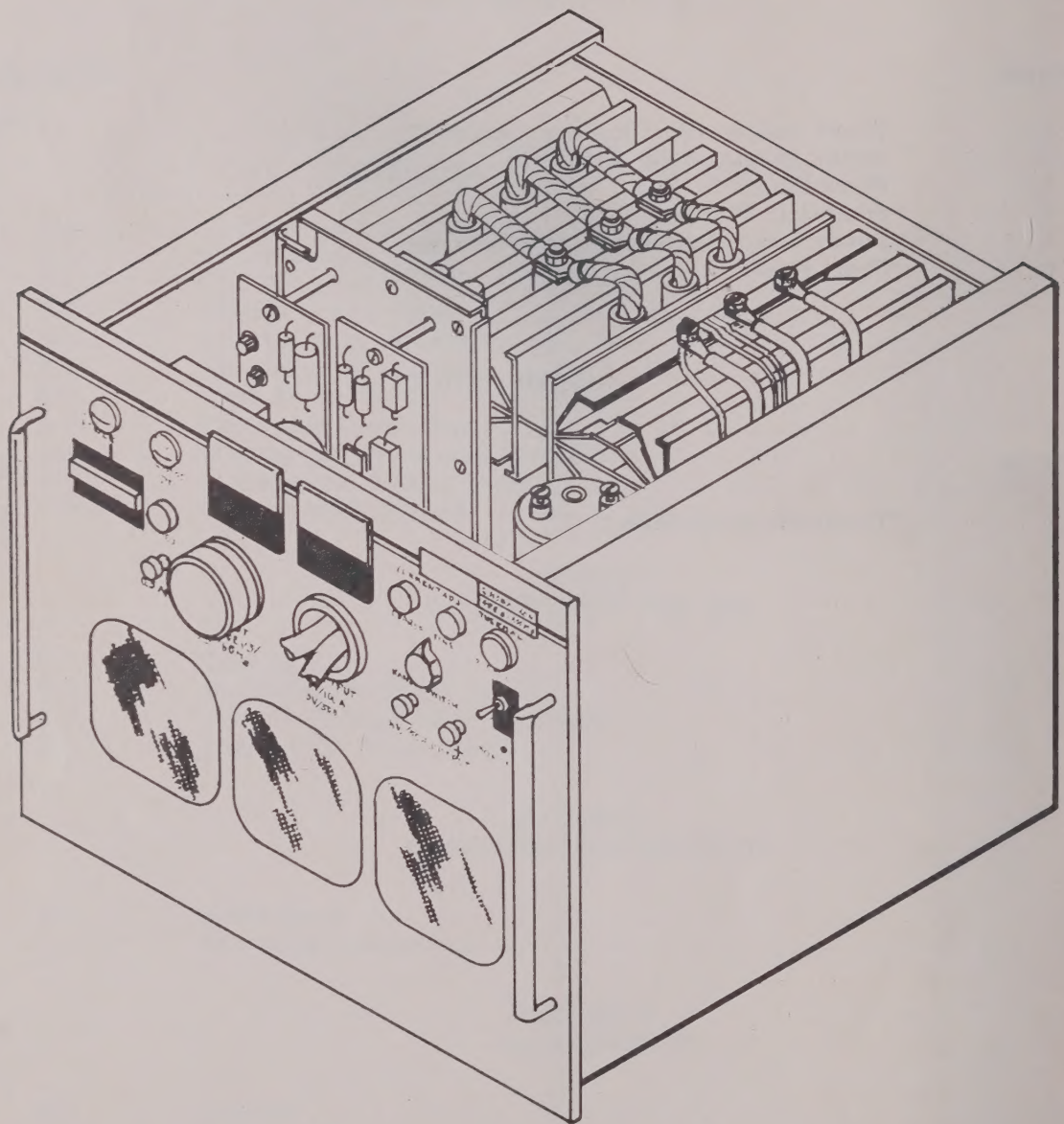


Figure 1. Power Supply with Top Cover Removed

POWER SUPPLY

MODEL QRE 3-300-M3

SECTION I

INTRODUCTION AND DESCRIPTION

1-1. GENERAL. This technical manual contains operating and maintenance instructions for the Power Supply, Model QRE 3-300-M3, manufactured by Raytheon/Sorensen Operation, South Norwalk, Connecticut. (See figure 1.)

1-2. DESCRIPTION.

a. The Power Supply accepts a 3-phase, 4 wire, 120/208-volt ac input at frequencies from 48 to 65 Hz and provides a highly regulated, precise dc output. The unit reacts extremely fast to load and line excursions and exhibits very low output ripple.

b. The use of silicon semi-conductors gives the Power Supply its wide ambient-temperature range, and as a maintenance feature, reduces the number of components. These components are protectively packaged in a compact sturdy cold-rolled steel case with a baked enamel finish. High dissipation components are mounted on extrusion-type heat sinks and are forced air cooled.

c. The front panel mounts all of the operating controls. (These controls are identified in paragraph 3-1.)

1-3. SPECIFICATIONS.

SIZE:	19-in. rack mount, 15-3/4 in. panel height, 18-1/4 in. deep
WEIGHT:	240-pounds (maximum)
INPUT RATING:	120/208, 3-phase, 50/60 Hz, ac
SERVICE CONDITIONS:	
Temperature:	+4 to 40°C
Humidity:	0 to 90 percent
Altitude:	0 to 10,000 ft.
OUTPUT RATING:	
Constant Current:	
Range:	(1) 0 to 300-amp dc (2) 0 to 100-amp dc (3) 0 to 30-amp dc

Coarse control range adjust:	(1) 0 to 300-amp dc is 100 percent of range adjustment (2) 0 to 100-amp dc is 100 percent of range adjustment (3) 0 to 30-amp dc is approximately 33 percent of range adjustment
Fine control range adjust:	4 percent of range
Fine control resolution:	0.01 percent of full scale
Voltage compliance:	0-3 volts on the 300A range 0-8 volts on the 30 and 100A ranges

REGULATION:

For combined line and load change:

0-300 amp range; 0-100 amp range:	±0.05 percent or ±150 ma, whichever is greater
0-30 amp range:	±0.05 percent or ±15 ma, whichever is greater

RIPPLE:

Maximum RMS ripple:

Range 1 and 2:	0.5 percent or 1500 ma, whichever is greater
Range 3:	0.5 percent or 150 ma, whichever is greater

TRANSIENT RESPONSE:

For 10 percent line change, output current is to be within:	Rnage 1 and 2 - 0.2 percent or 600 ma, whichever is greater Range 3 - 0.2 percent or 60 ma, whichever is greater

TEMPERATURE COEFFICIENT:

Range 1 and 2:	± (0.025 percent plus 30 ma) per degree C
Range 3:	± (0.025 percent plus 3 ma) per degree C

ONE HOUR STABILITY:

After 30 minute warm-up:

300-amp range:	0.05 percent plus 50 ma
100-amp range:	0.05 percent plus 50 ma
30-amp range:	0.05 percent plus 5 ma

PROTECTION:	Circuit breakers, fuse, thermostats
COOLING:	Fan-cooled

1-4. THEORY OF OPERATION.

1-5. PASSING STAGE PRINCIPLE. The Power Supply utilizes the series passing stage principle in regulating unit output. With this approach, a variable impedance absorbs the difference between the desired regulated output and the filtered "brute-force" direct current. The variable impedance is provided by a transistor stage which is fed a control signal that is related to the unit output. Passing stage operation is idealized in figure 2.

1-6. FUNCTIONAL DESCRIPTION. Figure 3 is the block diagram and figure 4 is the schematic diagram. Refer to these illustrations during the following analysis of all the circuits.

a. The ac voltage input is stepped-down by the input transformer and applied to a 3-phase full-wave bridge rectifier circuit. The output of the rectifier circuit is filtered and fed through the passing stage to the load. The passing stage is the regulating device, absorbing the difference between the rectifier and desired output voltages. The feedback loop includes a sensing circuit which samples the load current. This error current is converted to a voltage in a pre-amplifier. This voltage is compared with a fixed reference voltage generated by the reference power supply. Resulting error signals are differentially amplified and fed to passing stages through a series of driver amplifiers. The amplifiers signal then varies the impedance of the passing stages as a function of output current.

b. When the power supply is in the current regulating mode, the maximum output voltage is that which is set by the voltage adjust potentiometer, R6, on the front panel. The output voltage will rise with an increase of load resistance to maintain a constant current, and when the output voltage reaches the voltage set by the voltage adjust potentiometer, the voltage mode circuit will then convert the current regulator into a voltage regulator and maintain a constant voltage.

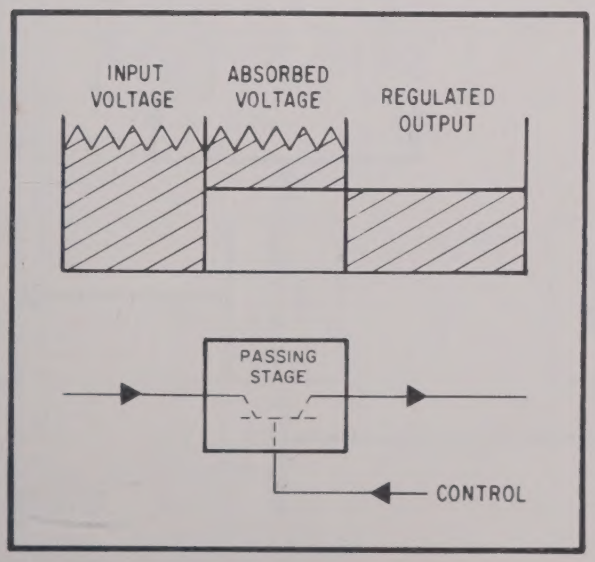


Figure 2. Series Passing Stage Principles

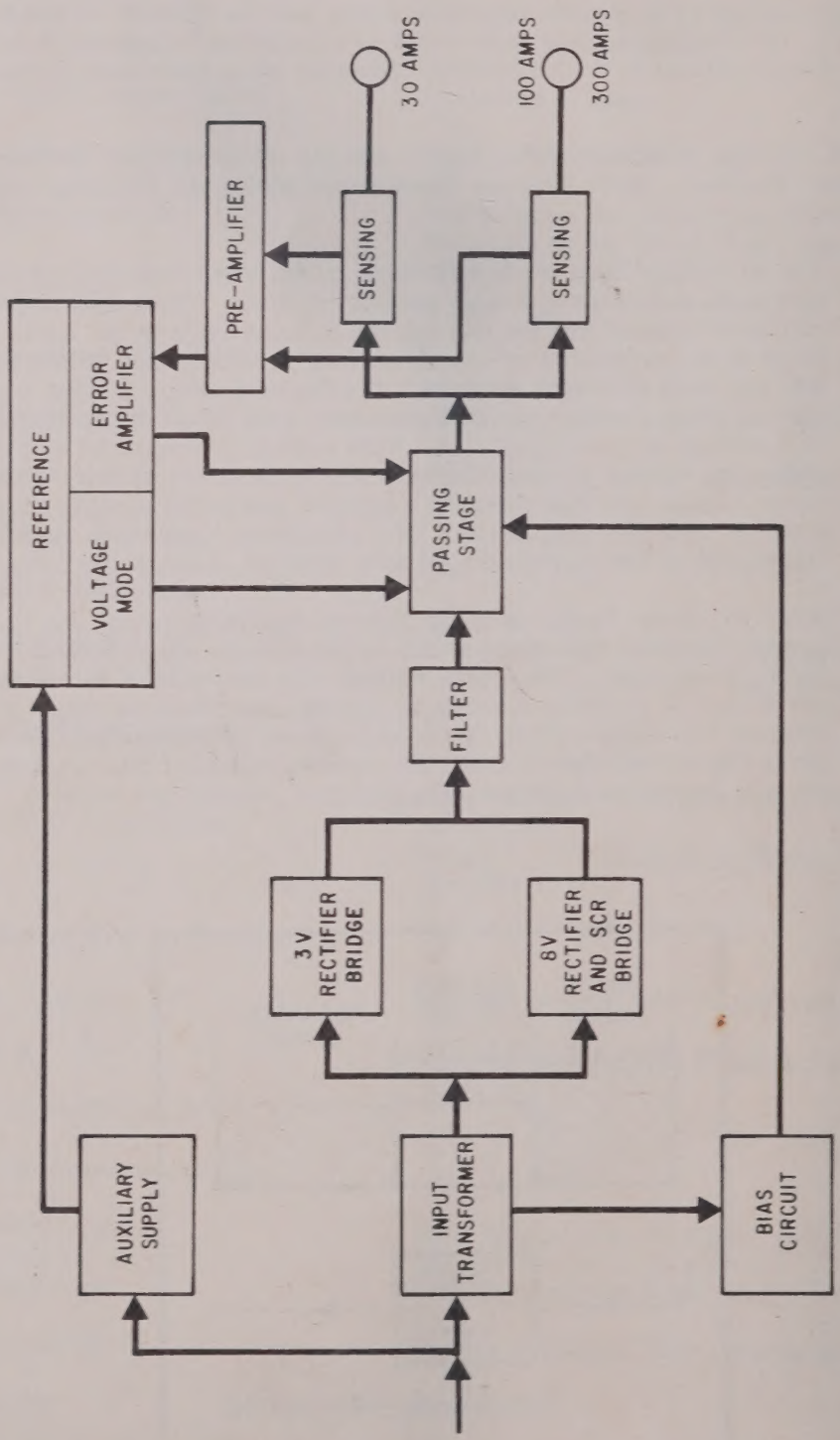


Figure 3. Block Diagram

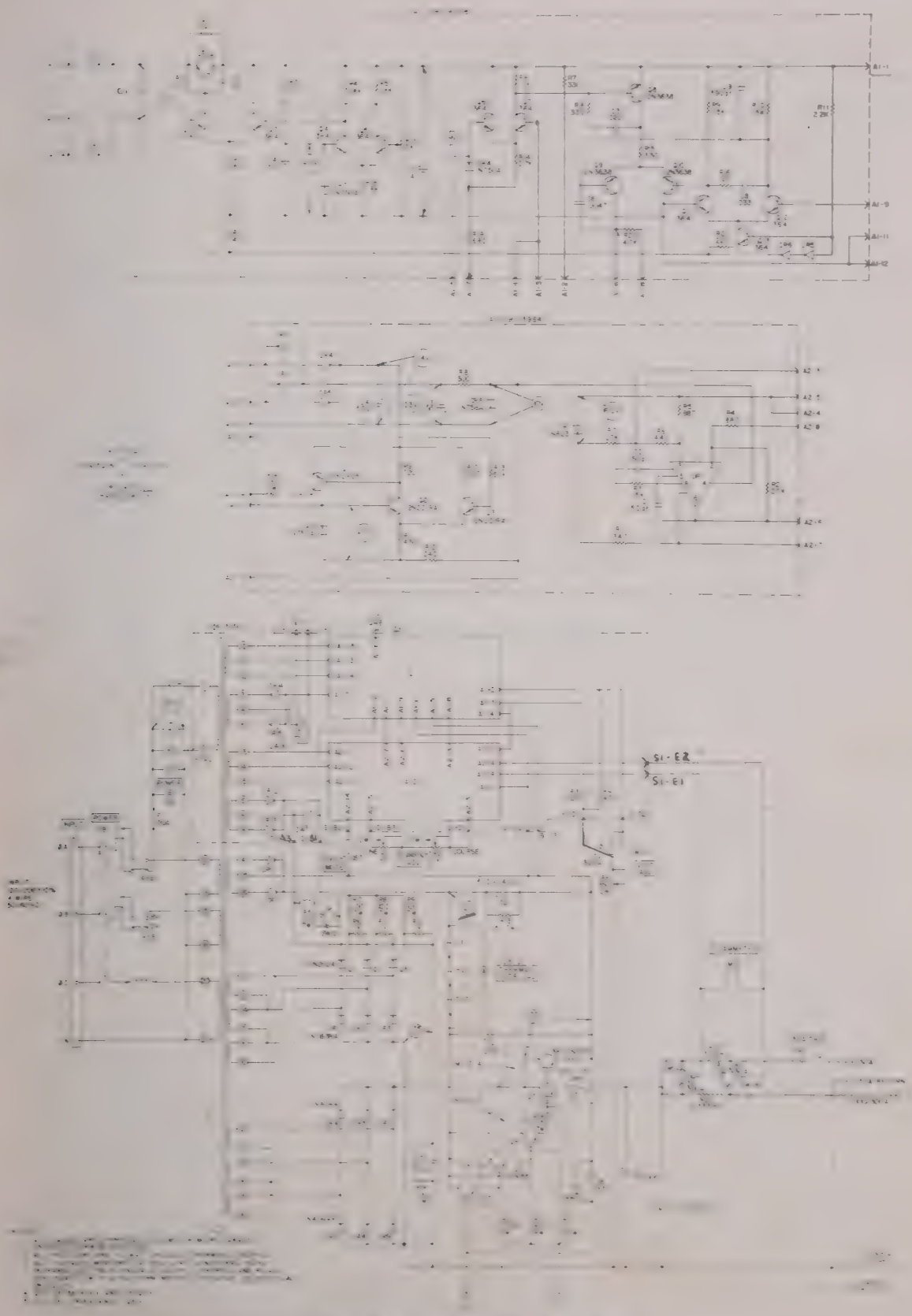


Figure 4. Schematic Diagram

1-7. INPUT POWER SECTION. The input power section includes main power transformer T1, auxiliary power transformer T2, a rectifier bridge consisting of CR4, CR5, CR6, CR7, CR8 and CR9 for 300-amperes output, a rectifier bridge consisting of Q1, Q2, Q3, and CR1, CR2, CR3 for 100-amperes and 30-amperes outputs, filter capacitor C4 and bleeder resistor R14. In range switch positions 8V/100A and 8V/30A. Relay K1 will energize and switch circuit breaker CB1 8-amperes coil into the input circuit. In addition, gate voltage will be applied to the controlled rectifiers Q1, Q2, and Q3. The 100A rectifier section CR1, CR2 and CR3 will take over, while the 300A section CR4, CR5, CR6, CR7, CR8 and CR9 is reversed biased and inopertive. Cooling fans (B1, B2, B3), power status light DS1, fuse F1 forms part of the T1 primary section. Power status light DS1 indicates the presence of input power at T2 and one phase of T1. A voltage mode status light, DS3, indicates a transfer from current to voltage regulator. Status light, DS2 indicates thermal overload (i.e., one or more fan failures).

1-8. REFERENCE POWER SUPPLY.

a. A constant reference voltage, used both in the sensing and error amplification section and in the voltage mode section, is provided by an internal supply consisting of potentiometer, A1-R13, double differential amplifier, A1-Q2, A1-Q3, and A1-Q4. A1-Q5, a series passing stage A1-Q1 and a zener reference diode, A1-CR3. Input to the regulator is derived from a full-wave, center-tapped circuit, A1-CR1 and A1-CR2, connected across a secondary of transformer T-2. Capacitor, A1-C1, provides input filtering, and capacitors, A1-C2, A1-C4, A1-C5 are used for stabilization.

b. The circuit functions as follows: A portion of the reference supply output is sampled across part of potentiometer A1-R13, i.e., schematically, that part across the base-emitter of A1-Q5 and resistor A1-R18. The sample is compared with the reference voltage developed by diode A1-CR3. Comparison error signals are differentially amplified and then fed to the base of passing stage A1-Q1.

c. For an example of circuit operation, assume that the reference output voltage tends to rise. The voltage across A1-R13 begins to increase and the base of A1-Q5 becomes more positive with respect to the base of A1-Q4 (note that the base-emitter voltage of A1-Q4 is held constant by A1-CR3). The operating current through A1-Q5 increases. The base of A1-Q2 therefore becomes less positive with respect to the base of A1-Q3. The operating current of A1-Q2 which is the drive on passing stage A1-Q1, drops and the impedance of A1-Q1 increases. Consequently, the voltage drop across A1-Q1 reduces the output to a regulated 9-volts.

1-9. SENSING AND ERROR AMPLIFICATION.

a. Output sensing and error amplification are provided by the sensing shunts (R20 and R21), and an operational amplifier, A2-OP. This is followed by a double-differential amplifier, A1-Q12, A1-Q11 and A1-Q10, A1-Q9. Transistor, A1-Q13 resistors, A1-R21 and A1-R11, and diodes, A1-CR5, A1-CR6, form a constant-current generator which maintains the sum of the operating currents through A1-Q12 and A1-Q11 at a fixed value.

b. The sensing resistors controls the potential at the input of A2-OP. This voltage is compared with the constant reference voltage supplied by A2-CR1. Error signals which develop are amplified by differential amplifiers A1-Q12, A1-Q11 and A1-Q10, A1-Q9. The amplifier output is fed to driver Q4 and subsequently to the base of the passing stages Q7 located on the heat sink. Q7 reacts by varying its IR drop to regulate the output to the value determined by the settings of R1 and R2.

c. To illustrate circuit operation, assume the output current begins to drop. The amplifier A2-OP output becomes more positive and the base of A1-Q12 will then become more positive with respect to the base of A1-Q11. Current through A1-Q12 will increase, and A1-Q11's operating current decreases. As a result, the base of A1-Q9 becomes more negative with respect to the base of A1-Q10. The operating current through A1-Q9, which is the amplifier output, increases. Consequently, the drive on the passing stages Q7 increases and Q7's impedance drops. Output current then increases to that value determined by the setting of resistors R1 and R2.

1-10. DRIVERS AND PASSING STAGE.

a. The drivers, Q4, Q5, and Q6, amplify the error signals from differential amplifier, (A1-Q10, A1-Q9). These amplified signals are fed to the bases of the passing stage transistors Q7. (Note that the passing stage has 36 paralleled transistors. Resistor R19 balance the voltage absorbed by each transistor.) Power for driver operation is derived from an unregulated supply utilizing rectifiers CR10 and CR11, filter capacitor, C3, and bleeder resistor, R13.

b. To illustrate the operation of the drivers and passing stage, the discussion of paragraph 1-9a is continued. As may be recalled, a dropping output voltage results in an increase in drive on the base of Q4. Q4's conduction level will rise, and its operating current, and therefore the drive on the base of Q5, will increase. Q5's operating current will then rise, and the drive on Q5 will be greater. As a result, the passing stage goes into a state of higher conduction (lower impedance) with an increase of drive current from Q6. The absorbed voltage across the stage decreases thereby raising the output current. This completes the feedback loop.

1-11. VOLTAGE MODE SECTION.

a. The voltage mode section is comprised of differential amplifier A1-Q6, A1-Q7, crossover transistor, A1-Q8 and zener diode, A1-CR4. The circuit when functioning to limit output voltage, reduces the operating current of differential amplifier, A1-Q10, A1-Q9 and thereby increases the impedance of the passing stage. Resistor, A1-R8, and capacitor, A1-C3 comprises the stabilization circuit.

b. To illustrate circuit operation, assume that an overvoltage condition (in excess of the voltage set by the voltage adjust potentiometer) occurs. The high output voltage increases the voltage on the base of A1-Q6 and the base becomes more positive with respect to the base of A1-Q7. The operating current through A1-Q6 increases and A1-Q7 current decreases. (The relatively large value of A1-R14 serves to maintain the sum of A1-Q6's and A1-Q7's operating currents almost constant.) As A1-Q7's operating current decreases, the voltage drop developed across A1-R6 decreases. This voltage, under normal conditions, is sufficient to maintain A1-Q8 in saturation. However, now as it decreases, A1-Q8 comes out of saturation and approaches cutoff. A1-Q9's operating current, which is the amplifier output to the driver and passing stages, is lowered, and Q7 develops a high impedance. The unit now holds the voltage constant while the output current varies inversely with the load resistance.

SECTION 2

PREPARATION FOR USE

2-1. GENERAL.

a. The Power Supply is mounted in a field case by the using activity. The Power Supply and field mounting kit are packed in one shipping container.

b. The field mounting kit contains the below listed material, (see figure 5).
(1) Slide Adapter Bracket, marked LH and RH, 2 each (5).
(2) Slides, 1 set marked LH and RH (8).
(3) Locator Pin Cabinet Bar, 1 each (3).
(4) Attaching Parts, 4 each, screw (4).
(5) Attaching Parts, 8 each, screw, washer, lockwasher, nut (6).
(6) Attaching Parts, 6 each, screw, lockwasher (7).
(7) Attaching Parts, 20 each, screw (9).
(8) Attaching Parts, 8 each, screw (10).
(9) Attaching Parts, 8 each, screw, washer, lockwasher (12).

2-2. UNPACKING THE POWER SUPPLY. (See figure 5.)

a. Carefully remove and check the contents of the shipping container.

b. Make a close visual inspection to determine any physical damage due to rough handling during shipment.

c. Check the security of the ammeter, voltmeter, circuit breakers, status indicator lights, terminals and receptacles mounted on the front panel.

d. Test switches and controls for positive action. Check the ammeter and voltmeter pointer zero setting. If necessary, reset to zero using the adjust screw.

e. Remove the screws securing the top and bottom covers to the chassis.

f. Inspect internal components for physical damage.

g. Replace the top and bottom covers.

2-3. TEST FOR DAMAGE AFTER UNPACKING. Refer to paragraph 3-2 for the procedure to test the Power Supply to determine if any damage occurred during shipment.

2-4. FIELD CASE ASSEMBLY. (See figure 5.) Mount the Power Supply in the field case as follows:

a. Remove the top cover of the Power Supply.

b. Remove the front cover from the field case (1).

c. Remove the shock mounted field structure (2) from the field case.

d. Assemble locator pin cabinet bar (3) to the rear of the frame with 4 each attaching parts (4).

e. Assemble the left hand and right hand slide adapter brackets to the front of the frame with 6 each attaching parts (7) making sure that holes 3, 4 and 5 from the bottom are used.

f. Assemble the left hand and right hand slide adapter brackets (5) to the rear of the frame with the 8 each attaching parts (6).

g. Assemble the left hand and right hand slides (8) to slide adapter bracket (5) with 20 each flat head screws (9).

h. Install the assembled shock mounted field structure (2) into field case (1).

i. Assemble Power Supply (11) to slides (8) with 8 each flat head screws (10).

j. Loosen the 2 locating pins on the top rear of the Power Supply. Slowly slide the Power Supply into the case and align the power supply locator pins into the cabinet locator pin bar (3) holes.

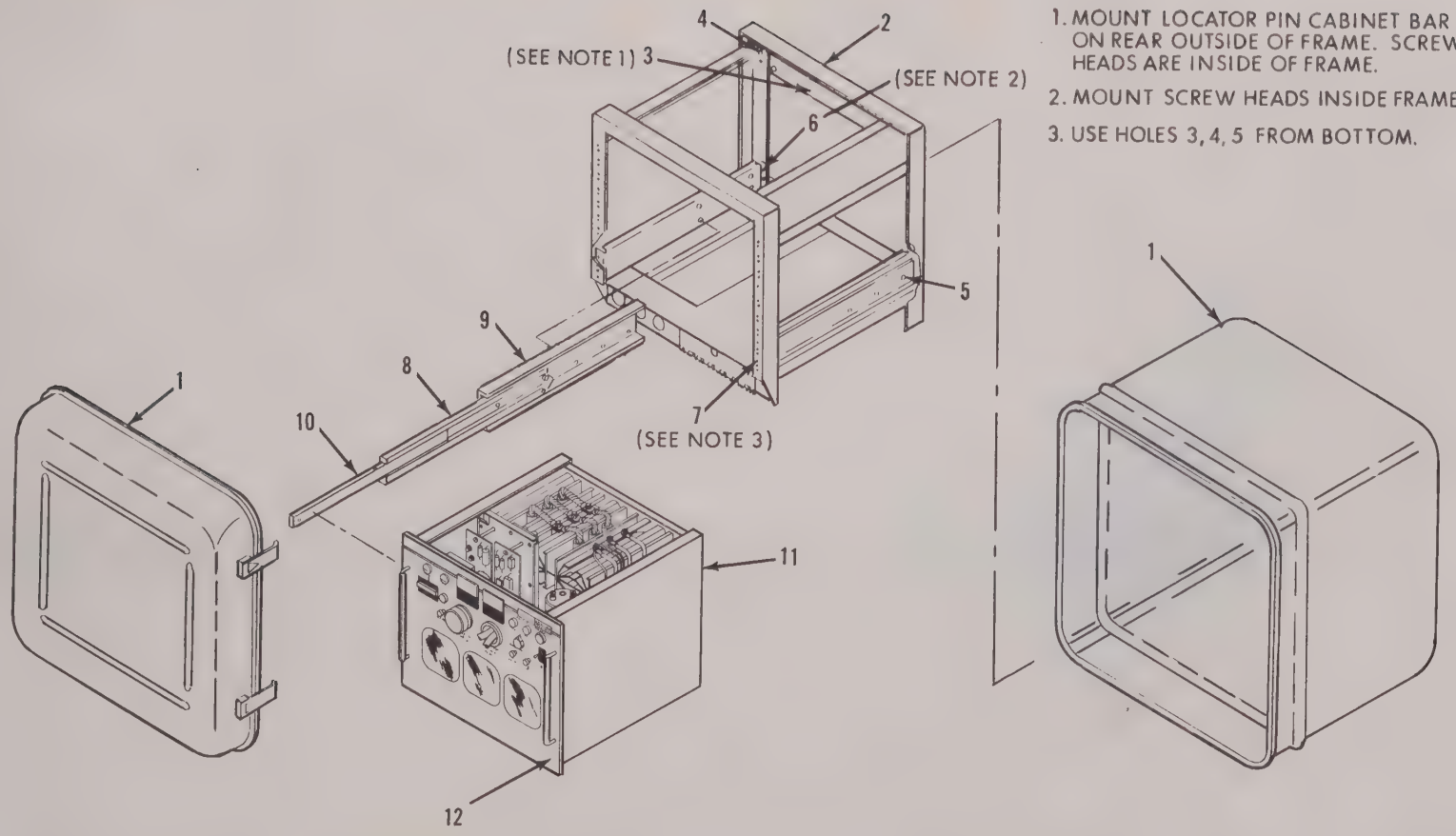
k. Slide out the Power Supply and tighten the 2 locator pins.

l. Replace the top cover.

m. Slide Power Supply into frame and fasten with 8 each attaching parts (12).

NOTES

1. MOUNT LOCATOR PIN CABINET BAR ON REAR OUTSIDE OF FRAME. SCREW HEADS ARE INSIDE OF FRAME.
2. MOUNT SCREW HEADS INSIDE FRAME.
3. USE HOLES 3, 4, 5 FROM BOTTOM.



1. Field Case with Cover Removed
2. Frame
3. Locator Pin Cabinet Bar
4. Screw, PNH (10-32 x 5/8 in. lg)
5. Slide Adapter Bracket
6. Attaching Parts
   Screw, PNH (10-32 x 5/8 in. lg)
   Washer (No. 10)
   Lockwasher (No. 10)
   Nut (No. 10-32)
7. Attaching Parts
   Screw, PNH (10-32 x 3/8 in. lg)
   Lockwasher (No. 10)
8. Slide
9. Screw, FLH (10-32 x 5/8 in. lg)
10. Screw, FLH (10-32 x 1 in. lg)
11. Power Supply
12. Attaching Parts
    Screw, PNH (10-32 x 5/8 in. lg)
    Washer (No. 10)
    Lockwasher (No. 10)

Figure 5. Power Supply Installation in Field Case

SECTION 3

OPERATING INSTRUCTIONS

3-1. FRONT PANEL. (See figure 6.)

a. ON/OFF INPUT POWER CIRCUIT BREAKER, CB1, (15) turns 3 phase, ac input power on and off and provides protection against excessive input current.

b. 30 A TRIP CIRCUIT BREAKER, CB2 (8) protects the 30-amperes supply against overloading.

c. PANEL STATUS LIGHTS.

(1) Power ON/OFF status light, DS1, (1) is a red status light indicating when ac power is applied to the primary of transformers, T1, T2 and the fan motors.

(2) THERMAL OVERLOAD status light, DS2, (7) is an amber status light indicating a unit shutdown due to an over-temperature condition. When lit, dc output voltage is automatically reduced to zero.

(3) VOLTAGE MODE STATUS light, DS3 (2) is a green status light indicating when the power supply is in the voltage mode.

d. METERS.

(1) DC VOLTMETER, M1, (3) monitors output voltage. It is rated at 0-8.0 vdc.

(2) DC AMMETER, M2, (4) monitors output load current. It is a dual range ammeter, 0-35 and 0-350 amperes dc.

e. CONTROLS.

(1) VOLT ADJ control, R6, (14) adjusts the maximum compliance voltage from 0 to 3 volts (300 amperes range) or 0 to 8 volts (100 and 30 amperes range).

(2) CURRENT ADJ controls, R1 and R2, are separate COARSE (5) and FINE (6) output current adjust controls.

(3) RANGE SWITCH, SW1, (9) is a 3-position selector switch selecting one of the following ranges: 3V/300A, 8V/100A, or 8V/30A.

f. CONNECTIONS.

(1) 8V 30A OUTPUT terminals (10). One red (+) and one (–) black output binding posts are provided.

(2) OUTPUT, 8V/100A or 3V/300A, (11). Two 24-inch output cables are provided for 8V/100A and for 3V/300A output. (One conductor +, one conductor -.)

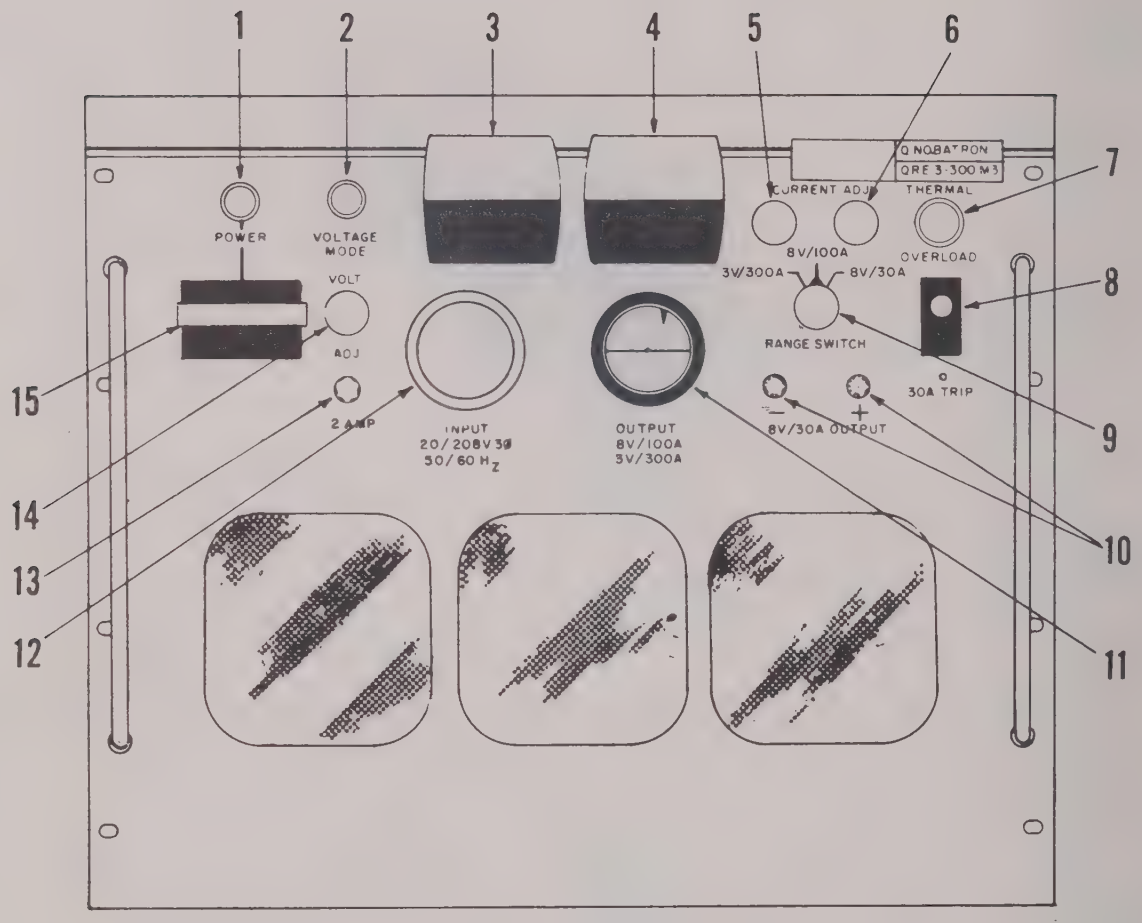


Figure 6. Front Panel

1. Power on/off status light DS1
2. VOLTAGE MODE status light DS3
3. DC Voltmeter M1
4. DC Ammeter M2
5. COARSE CURRENT ADJ control R2
6. FINE CURRENT ADJ control R1
7. THERMAL OVERLOAD status light DS2
8. 30 A TRIP Circuit Breaker CB2
9. RANGE SWITCH SW1
10. 8V/30 A OUTPUT terminals
11. OUTPUT, 8V/100 A, 3V/300 A panel opening
12. INPUT 120/208V, 3Ø, 50/60 Hz receptacle
13. 2.0 AMP Fuse F1
14. VOLT ADJ control R6
15. ON/OFF Input Power Circuit Breaker CB1

(3) INPUT 120/208 V, 3Ø, 50/60 Hz input receptacle, P1, (12). (A mating connector is also supplied.)

g. FUSE F-1 (13). Fuse F-1 is rated at 2.0-amperes.

3-2. OPERATING INSTRUCTIONS. The Power Supply is designed for operation from 120/208, 3-phase, 50/60 Hz, input power source. Input power connection is by means of the 4-wire input line cord connected to INPUT 120/280 V, 3Ø, 50/60 Hz receptacle on the front panel. Two 24-inch long cables are provided for the high current outputs. Attach them to the output buss bars in the unit and feed through OUTPUT panel opening (11, figure 5) in the front panel.

NOTE

When connected to the power source, the Power Supply is ready to be tested to determine if it is operational.

a. Place ON/OFF power circuit breaker, CB1, to OFF position.

b. Rotate COARSE CURRENT ADJ control, R2, full counterclockwise and FINE CURRENT ADJ, R1, control full clockwise.

c. Roate VOLT ADJ control, R6, full counterclockwise.

d. Place RANGE SWITCH, SW1, to 8V/30A position.

e. Place ON/OFF power circuit breaker, CB1, to ON position. POWER status light should illuminate red and VOLTAGE MODE status light should illuminate green.

f. Rotate VOLT ADJ control, R6, clockwise until dc voltmeter, M1, reads 8-volts.

g. Place a short (No. 12 AWG wire or equivalent) across the 30A output terminals.

h. Place the 30A trip circuit breaker, CB2, to ON position.

i. VOLTAGE MODE status light, DS3 should be off and dc voltmeter, M1, should be less than 0.5-volt.

j. Rotate COARSE CURRENT ADJ control, R2, slowly clockwise until dc ammeter, M2, reads 30A on the 35A range.

k. Place ON/OFF power circuit breaker, CB1, to OFF position.

l. The Power Supply is now ready for operation.

SECTION 4

MAINTENANCE

4-1. GENERAL.

WARNING

Before working on the Power Supply, the input power should be cut off by disconnecting the line cord.

a. No matter how well equipment is designed and manufactured, faults will always occur under service conditions. When such faults occur, the serviceman must be able to locate and correct them as rapidly as possible. When trouble-shooting, keep in mind that not all faulty operation is due to defects in the equipment. For example, an operator may have failed to perform a required function. The Power Supply has been designed for lone term trouble free operation. Little attention beyond normal maintenance is required. Components of the Power Supply have been carefully selected to assure maximum efficiency in operation.

b. Preventative maintenance is work performed on equipment (usually when it is not in use) to keep it in good working order so that breakdowns and needles interruptions in service will be kept to a minimum. Preventative maintenance differs from trouble shooting and repair since its object is to prevent certain types of trouble from occurring.

c. Failure may occur due to breakdown of capacitors or resistors. Test for voltages indicated on figure 4 and investigate serious discrepancies.

d. A faulty capacitor may cause an overload of associated resistors, which should be checked for any change in resistance value. A shorted resistor may be deteced by scorching or discoloration marks on the surface of the resistance. An open capacitor may cause unwanted oscillations and may be checked by connecting a good capacitor across it.

4-2. DISASSEMBLY Disassemble the Power Supply only to the extent necessary to effect clearing, inspection, repair or replacement. Unsolder and disconnect wires only as required to accomplish disassembly. No special tools are needed. Great care should be used in handling parts to ensure that they remain free from mars and distortion. Keep disassembled parts in clean, covered containers when not in use. When wire leads are disconnected, tag them to ensure correct replacement. Use caution to tighten screws, bolts and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be broken or damaged.

4-3. INSPECTION.

a. To prevent failure of the Power Supply due to corrosion, dust and other destructive ambient conditions, inspect the chassis for signs of dirt, dampness, molding, charring or corrosion semi-annually.

b. The following inspection standards shall be met:

(1) Check for completeness and satisfactory condition of the Power Supply.

(2) Check the case for indentures, scratches and corrosion.

(3) All painted surfaces shall be free from discoloration, scratches, nicks or blisters.

(4) Inspect terminal blocks for loose connections, cracks and breaks.

(5) Check that links are tight.

(6) Inspect for worn or loose parts.

(7) Check the fuse, circuit breakers, and lamps.

(8) Check the meters, switches and controls for security of mounting.

(9) Inspect the security of mounting of components.

(10) Inspect switches for positive action.

(11) Inspect switches for condition of contacts and burned spots.

(12) Inspect transformers and controls for overheating or loose connections.

(13) Inspect wiring and buss bars for broken or loose connections, chafed or frayed insulation and evidences of overheating.

(14) All wires shall be properly insulated and securely soldered. Look carefully for frayed or broken wires.

(15) Check all soldered connections for security and corrosion.

(16) Inspect capacitors for leaks, bulges and discoloration.

(17) Inspect resistors for cracks, chipping, blistering, discoloration and moisture.

(18) Inspect all terminals for corrosion, dirt and loose contacts.

(19) All threads shall be clean and free from burrs and stripping.

4-4. CLEANING.

a. WIRE AND NON-METALLIC PARTS. Use a fine stream of compressed air or a vacuum cleaner to remove as much dirt and dust as possible. Loosen remaining particles with a soft brush and then blow them away. A clean, dry, soft, lint and oil free cloth may be used to wipe parts and surfaces provided no abrasive action results.

b. PAINTED SURFACES. Wash with a mild soap-and-water solution. Rinse with clean water. Wipe the parts with a clean, damp, lintless cloth, and dry with clean, dry, oil free compressed air.

c. METALLIC PARTS. Use dry cleaning solvent (Federal Specification P-S-661) to clean metallic parts. If necessary, wipe with a soft sloth dampened with dry cleaning solvent, and rerinse in the solvent. Make certain that any deposited lint has been removed. Dry with clean, dry, oil free compressed air.

CAUTION

Do not let dry cleaning solvent (Federal Specification P-S-661) to come into contact with painted surfaces, wire, electrical component or non-metallic parts.

4-5. LUBRICATION. No lubrication is required.

4-6. REPAIR AND REPLACEMENT.

a. REPAIR. Repair of parts is impractical and should not be attempted, with the following exceptions.

(1) Painted parts from which paint has been removed during normal service use should be repainted, provided the part is in good repair and meets operational requirements. Refinish with zinc chromate primer (Military Specification MIL-P-8585), and semi-gloss touch-up enamel (Federal Standard FED-STD-595, Color 26440).

(2) Slight scratches and nicks may be removed from parts with crocus cloth (Federal Specification P-C-458), provided the removal of the defect in no way affects the operation of the parts.

(3) All defective parts shall be replacted with new or serviceable parts which will permit serviceable operation of the Power Supply.

b. REPLACEMENT OF DEFECTIVE PARTS. When removing a part, bend wires only enough to permit removal and replacement of the part. When unsoldering a joint, apply the soldering iron just long enough to soften the particular joint. Excessive application of the soldering iron may loosen other nearby connections. Clean and tin wire and terminal ends before attempting to make a joint. Fasten the wire by twisting it around the terminal. Clip it close before soldering. Heat the wire and terminal just hot enough for the solder to flow into the joints. Take care not to make any cold solder joints. Remove excess solder (Federal Specification QQ-S-571, Type SN60) and rosin base flux (Specification MIL-F-20329).

c. PRINTED CIRCUIT BOARDS. The Power Supply utilizes several sophisticated networks. To minimize troubleshooting and repair time, it is recommended that printed circuit boards, which contain the networks, be replaced whenever defective.

4-7. TROUBLESHOOTING. Troubleshooting and repairs are necesarily limited in scope by the test equipment, tools and spare parts that are available. As a result, troubleshooting is based on the performance of the Power Supply and the use of observation in determining such troubles caused by defective components and in localizing the component that is at fault. Mechanical failure may cause faulty operation as well as malfunctioning of electrical components. If mechanical trouble exists, it must be eliminated before the electrical circuits can be properly adjusted. Table I is a troubleshooting guide. It will be helpful to refer to the schematic diagram, figure 4.

4-8. CALIBRATION OF REFERENCE VOLTAGE.

a. Rotate VOLT ADJ control, R6, full counterclockwise.

b. Rotate COARSE CURRENT ADJ control, R2, full counterclockwise and FINE CURRENT ADJ control R1, full clockwise.

c. Set RANGE SWITCH, SW1, to the 8V/30A position.

d. Apply input power (208-volts). Set ON/OFF input power circuit breaker, CB1, to ON position.

e. If the dc voltage reading across capacitor A1-C5 is not 9.0 ± 0.1 volts dc, adjust potentiometer, R13.

NOTE

If any components are changed in the reference, supply recalibrate to obtain the precise 9.0 ± 0.1 volt dc rereference voltage.

4-9. PASSING STAGE POWER DISTRIBUTION TEST. Before unit is returned to service the 36 passing stages should be checked to determine if the current is being shared by each transistor.

a. Rotate VOLT ADJ control, R6, full clockwise.

b. Rotate COARSE CURRENT ADJ control R2 and FINE CURRENT ADJ control R1 full counterclockwise.

c. Set RANGE SWITCH, SW1, to 3V/300A position.

d. Short the high current output cables.

e. Apply input power (208 volts). Set ON/OFF input power circuit breaker, CB1, to ON position.

f. Rotate COARSE CURRENT ADJ control, R2, clockwise until the ammeter M2 reads 300 A.

g. Check the voltage across each passing stage emitter resistor R19. Use convenient test points on the terminal board at the bottom of each transistor heat sink. Voltages should be within 20 percent of each other.

TABLE I. TROUBLESHOOTING GUIDE

Symptom	Probable Cause	Remedy
1. High output voltage	1a. Shorted passing stage	1a. Check the 36 (total) passing stage transistors (Q7) and drivers Q4, Q5, Q6. Replace defective parts.
	1b. Defective component on a printed circuit board.	1b. Replace printed circuit board.
	1c. Open voltage adjust potentiometer.	1c. Check and replace.
	1d. Printed circuit board connector not making good contact in socket.	1d. Check all surfaces. Be sure all surfaces are clean and making good contact.

TABLE I. TROUBLESHOOTING GUIDE (Cont)

Symptom	Probable Cause	Remedy
2. Low or no output voltage.	2a. No input voltage into transformer.	2a. Check input line connections circuit breakers and connections on main transformer. Check for proper input voltages.
	2b. See 1b, 1d, 1e.	2b. See 1b, 1d, 1e.
3. Circuit breaker CB1	3a. Shorted main rectifier CR1, CR2, CR3, Q1, Q2, Q3 (30 or 100-amp); CR4 to CR9 (300-amp)	3a. Check and replace.
	3b. Shorted passing stage.	3b. See 1a.
	3c. Shorted C3 or C4.	3c. Check and replace.
	3d. See 1b.	3d. See 1b.
	3e. RANGE SWITCH SW1 in 8V/100A or 8V/30A position with 300A output shorted.	3e. SW1 is in wrong position. Switch to 3V-300A position.
	3f. Shorted winding on main power transformer, T1.	3f. Check and replace.
4. Circuit breaker CB2 tripped	4a. RANGE SWITCH SW1 in 3V/300A or 8V/100A position with 30A output shorted.	4a. SW1 is in wrong position. Switch to 8V/30A position.
	4b. Overload.	4b. Remove load.
5. Fuse, F1, blown	5a. Shorted fan motor	5a. Check and replace.
	5b. Shorted capacitor, C1 and C2.	5b. Check and replace.
	5c. Shorted winding on transformer, T2.	5c. Check and replace.

Ref Desig	Description	Raytheon/ Sorensen Part No.	Mfr Part No.	Mfr Fed Supply Code	Federal Stock No.
A2-R1	RESISTOR; 374 ohm, ±1 , 1/2W	28-1380	CEC-T2-374	07716	
A2-R2	RESISTOR: 20K ohm, ±1 , 1/2W	28-1381	CEC-T2-20000	07716	
A2-R3	RESISTOR: 1.5K ohm, ±10 , 1/2W	27-171	EB1521	01121	
A2-R4	RESISTOR: 887 ohm, ±1 , 1/2W	28-1216	CEC-T-2-887	07716	
A2-R5	RESISTOR: 887 ohm, ±1 , 1/2W	28-1216	CEC-T-2-887	07716	
A2-R6	RESISTOR: 442 ohm, ±1 , 1/2W	28-1382	CEC-T2-442	07716	
A2-R7	RESISTOR: 20K ohm, ±1 , 1/2W	28-1381	CEC-T2-20000	07716	
A2-R8	RESISTOR: 300 ohm, ±5 , 1/2W	27-1187	EB3015	01121	
A2-R9	RESISTOR: 220 ohm, ±5 , 1/2W	27-1171	EB2215	01121	
A2-R10	RESISTOR: 220 ohm, ±5 , 1/2W	27-1171	EB2215	01121	
A2-R11	RESISTOR: 430 ohm, ±5 , 1/2W	27-1104	EB4315	01121	
A2-R12	RESISTOR: 240 ohm, ±5 , 1/2W	27-1189	EB2415	01121	
A2-R13	RESISTOR: 5.1K ohm, ±5 , 1/2W	27-135	EB5125	01121	
A2-R14	RESISTOR: 330 ohm, ±5 , 3W	27-397-85	3X330	63743	
A2-XOP	SOCKET: Amplifier	42-179	8058-39G3	91506	
B1	FAN	91-1940	2500	23936	
B2	FAN	91-1940	2500	23936	
B3	FAN	91-1940	2500	23936	
C1	CAPACITOR: 2400 UF, 25V	24-2452-6	34D248G025JS2	56289	
C2	CAPACITOR: 2400 UF, 25V	24-2452-6	34D248G025JS2	56289	
C3	CAPACITOR: 14,000 UF, 15V	24-2454-6	32D143G015AF6B	56289	
C4	CAPACITOR: 7700 UF, 25V	24-2544-8	32D772G025AF6B	56289	
C5	CAPACITOR: 0.022 UF, 200V	24-2409-9	V146XR-24	00656	
C6	CAPACITOR: 200 UF, 25V	24-2472	30D207G025DH2	56289	
C7	CAPACITOR: 100,000 UF, 10V	24-2462-3	32D104G010DF6B	56289	
C8	CAPACITOR: 500 UF, 10V	24-2491	34D507G010GE2	56289	
CB1	CIRCUIT BREAKER: 3-pole, 2-pole, 12A/8A, curve "5", 1-pole, 12A, series trip	92-360	72-266-1	74193	
CB2	CIRCUIT BREAKER: AM 12-33 dc, curve "5"	92-361	AM12-33CURVE 5	74193	
CR1	RECTIFIER: 40A, 50V	26-1122	1N1183RA	03058	
CR2	RECTIFIER: 40A, 50V	26-1122	1N1183RA	03508	
CR3	RECTIFIER: 40A, 50V	26-1122	1N1183RA	03508	
CR4	RECTIFIER: 275A, 50V	26-1029-1	1N4044	89661	
CR5	RECTIFIER: 275A, 50V	26-1029-1	1N4044	89661	
CR6	RECTIFIER: 275A, 50V	26-1029-1	1N4044	89661	
CR7	RECTIFIER: 275A, 50V	26-1029-2	1N4044R	89661	
CR8	RECTIFIER: 275A, 50V	26-1029-2	1N4044R	89661	
CR9	RECTIFIER: 275A, 50V	26-1029-2	1N4044R	89661	
CR10	RECTIFIER: 12A, 50V	26-1123	1N1199A	89661	
CR11	RECTIFIER: 12A, 50A	26-1123	1N1199A	89661	
CR12	RECTIFIER: 1.1A, 100V	26-1027-4	HC68	13327	
CR13	RECTIFIER: 1.1A, 100V	26-1027-4	HC68	13327	
CR14	RECTIFIER: 375 MA, 100V	26-158-1	CER68	11961	
CR15	RECTIFIER: 375 MA, 100V	26-158-1	CER68	11961	
CR16	RECTIFIER: 375 MA, 100V	26-158-1	CER68	11961	
DS1	LAMP: NE51	42-301	40	03508	
DS2	LAMP: 1829, 28V, 0.07A	42-315	1829	03508	
DS3	LAMP: T-3-1/4, 6.3V, 0.05A	42-341	1302	03508	
F1	FUSE: 2.0A	42-408	AGC2	71400	
J1	CONNECTOR: AC input, 4-wire, 15A/250V	42-649	7413	74545	

SEE TB 43-0001-32-3
FOR CHANGE MADE BELOW
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Ref Desig	Description	Raytheon/ Sorensen Part No.	Mfr Part No.	Mfr Fed Supply Code	Federal Stock No.
M1	VOLTMETER: 0-8V	94-549-19	94-549-19	95938	
M2	AMMETER: Dual scale, 0-35/0-350A	94-460	94-460	55938	
P1	RECEPTACLE: AC input, 4-wire, 15A/250V	42-543	7408	74545	
Q1	THYRISTOR: VFOM, 50V, 110A RMS	26-1124	2N2024	89661	
Q2	THYRISTOR: VFOM, 50V, 110A RMS	26-1124	2N2024	89661	
Q3	THYRISTOR: VFOM, 50V, 110A RMS	26-1124	2N2024	89661	
Q4	TRANSISTOR: Silicon, NPN	18-142	~~40312~~ 40321	49675	
Q5	TRANSISTOR: Silicon, NPN	18-151	2N3055	49675	
Q6	TRANSISTOR: Silicon, NPN	18-202	2N3771	49675	
Q7	TRANSISTOR: Silicon, NPN	18-202	2N3771	49675	
R1	POTENTIOMETER: 50 ohm, ±3 , 2W	29-582	35005-2-500	80294	
R2	POTENTIOMETER: 1000 ohm, ±10 , 2W	29-500	140-6906	12697	
R3	RESISTOR: 220 ohm, ±10 , 1/2W	27-101	EB2211	01121	
R4	RESISTOR: 470 ohm, ±5 , 1/2W	28-2074	RL20S471J	14674	
R5	RESISTOR: 22 ohm, ±5 , 7W	27-470-57	7X22	63743	
R6	POTENTIOMETER: 350 ohm, ±10 , 2W	29-570	140-6903	12697	
R7	RESISTOR: 100 ohm, ±5 , 7W	27-470-73	7X100	63743	
R8	RESISTOR: 100 ohm, ±5 , 7W	27-470-73	7X100	63743	
R9	RESISTOR: 100 ohm, ±5 , 7W	27-470-73	7X100	63643	
R10	RESISTOR: 1000 ohm, ±5 , 1/2W	27-103	EB1021	01121	
R11	RESISTOR: 1000 ohm, ±5 , 1/2W	27-103	EB1021	01121	
R12	RESISTOR: 1000 ohm, ±5 , 1/2W	27-103	EB1021	01121	
R13	RESISTOR: 51 ohm, ±5 , 7W	27-470-66	7X51	63743	
R14	RESISTOR: 100 ohm, ±5 , 7W	27-470-73	7X100	63743	
R15	RESISTOR: 2700 ohm, ±10 , 1W	28-705	GB2721	01121	
R16	RESISTOR: 820 ohm, ±5 , 3W	27-397-95	3X820	63743	
R17	RESISTOR: 75 ohm, ±5 , 20W	27-614	20F75	63743	
R18	RESISTOR: 0.15 ohm, ±5 , 7W	27-470-5	7X0-5	63743	
R19	RESISTOR: 0.075 ohm, ±5 , 12.5W	27-653	12.5X0.075	63743	
R20	SHUNT: 100 MV, 30A	94-045	58A53-1-30-100	99246	
R21	SHUNT: 100 MV, 300A	94-046	58A53-2-300-100	99246	
RL1	RELAY: DPDT, 12 VDC	92-935	WU012-159	73096	
SW1	SWITCH: 4-pole, 3-position	45-233	2514	71590	
T1	TRANSFORMER: Power	126-3098	126-3098	55938	
T2	TRANSFORMER: Auxiliary	126-3100	126-3100	55938	
TS1	SWITCH: Thermal, 15A, 120 VAC, SPST	92-517	SERIES 20700L, OPEN 230°F, CLOSE 175°F	82647	
TS2	SWITCH: Thermal, 15A, 120 VAC, SPST	92-517	SERIES 20700L, OPEN 230°F, CLOSE 175°F	82647	
TS3	SWITCH: Thermal, 15A, 120 VAC, SPST	92-517	SERIES 20700L, OPEN 230°F, CLOSE 175°F	82647	

Ref Desig	Description	Raytheon/ Sorensen Part No.	Mfr Part No.	Mfr Fed Supply Code	Federal Stock No.
XA1	SOCKET: Printed circuit board	42-1385	00-6007-015-940-002	11769	
XA2	SOCKET: Printed circuit board	42-1385	00-6007-015-940-002	11769	
XDS1	PILOT LIGHT ASSY: (Red)	42-382	147-1144-2	74970	
XDS2	PILOT LIGHT ASSY: (Amber)	43-322	147-1142-4	74970	
XDS3	PILOT LIGHT ASSY: (Green)	43-341	147-1142-3	74970	
XF1	FUSEHOLDER	42-757	HMB	71400	
	TERMINAL: Output, 30A, Red	4-502	DF30RC	58474	
	TERMINAL: Output, 30A, Black	4-503	DF30RC	58474	
	PRINTED CIRCUIT BOARD A-1, Part no. 79-163				
A1-C1	CAPACITOR: 100 UF, 25V	24-2279-14	TE1211	56289	
A1-C2	CAPACITOR: 0.01 UF, 200V	24-2409-7	V146XB-22	00656	
A1-C3	CAPACITOR: 0.022 UF, 200V	24-2409-9	V146XR-24	00656	
A1-C4	CAPACITOR: 50 UF, 25V	24-2279-12	TE1209	56289	
A1-C5	CAPACITOR: 4 UF, 50V	24-2280-4	TE1302	56289	
A1-C6	CAPACITOR: 0.0047 UF, 200V	24-2409-5	V146XR-20	00656	
A1-C7	Not Used				
A1-C8	CAPACITOR: 0.033 UF, 200V	24-2409-10	V146XR-25	00656	
A1-C9	CAPACITOR: 390 PF, 500V	24-053	CM20D391F	93790	
A1-CR1	RECTIFIER: 375 MA, 100V	26-158-1	CER68	11961	
A1-CR2	RECTIFIER: 375 MA, 100V	26-158-1	CER68	11961	
A1-CR3	DIODE: Zener, 4.7V, 400 MW	26-211	1N750A	04713	
A1-CR4	DIODE: Zener, 4.7V, 400 MW	26-211	1N750A	04713	
A1-CR5	RECTIFIER: 100 MA, 50V, P1V	26-1017	RD9119	94145	
A1-CR6	RECTIFIER: 100 MA, 50V, P1V	26-1017	RD9119	94145	
A1-Q1	TRANSISTOR: Silicon, PNP	18-146	RT9338	94145	
A1-Q2	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q3	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q4	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q5	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q6	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q7	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q8	TRANSISTOR: Silicon, PNP	18-143	2N3638	07263	
A1-Q9	TRANSISTOR: Silicon, PNP	18-143	2N3638	07263	
A1-Q10	TRANSISTOR: Silicon, PNP	18-143	2N3638	07263	
A1-Q11	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q12	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-Q13	TRANSISTOR: Silicon, NPN	18-144	FSC3641	07263	
A1-R1	RESISTOR: 390 ohm, ±10 , 1W	28-703	GB3911	01121	
A1-R2	RESISTOR: 220 ohm, ±10 , 1/2W	27-101	EB2211	01121	
A1-R3	RESISTOR: 221 ohm, ±5 , 1/2W	28-1188	CEC-T0-221	07716	
A1-R4	RESISTOR: 1.8K ohm, ±10 , 1/2W	27-176	EB1821	01121	
A1-R5	RESISTOR: 1.8K ohm, ±10 , 1/2W	27-176	EB1821	01121	
A1-R6	RESISTOR: 1.2K ohm, ±10 , 1/2W	27-1110	EB1221	01121	
A1-R7	RESISTOR: 330 ohm, ±5 , 1/2W	28-2054	RL20S331J	14674	
A1-R8	RESISTOR: 330 ohm, ±10 , 1/2W	27-102	EB3311	01121	
A1-R9	RESISTOR: 1.5K ohm, ±10 , 1/2W	27-171	EB1521	01121	
A1-R10	RESISTOR: 1.5K ohm, ±10 , 1/2W	27-171	EB1521	01121	

Ref Desig	Description	Raytheon/ Sorensen Part No.	Mfr Part No.	Mfr Fed Supply Code	Federal Stock No.
A1-R11	RESISTOR: 2.2K ohm, ±10 , 1/2W	27-152	EB2221	01121	
A1-R12	RESISTOR: 820 ohm, ±10 , 1/2W	27-182	EB8211	01121	
A1-R13	POTENTIOMETER: 2K ohm, ±10 , 2W	29-409	140-6738	12697	
A1-R14	RESISTOR: 2.7K ohm, ±10 , 1/2W	27-174	EB2721	01121	
A1-R15	RESISTOR: 330 ohm, ±10 , 1/2W	27-102	EB3311	01121	
A1-R16	RESISTOR: 120 ohm, ±10 , 1/2W	27-1107	EB1211	01121	
A1-R17	RESISTOR: 47 ohm, ±10 , 1/2W	27-181	EB4701	01121	
A1-R18	RESISTOR: 1.8K ohm, ±10 , 1/2W	27-176	EB1821	01121	
A1-R19	RESISTOR: 680 ohm, ±10 , 1/2W	27-156	EB6811	01121	
A1-R20	RESISTOR: 4.7K ohm, ±10 , 1/2W	27-107	EB4721	01121	
A1-R21	RESISTOR: 220 ohm, ±10 , 1/2W	27-101	EB2211	01121	
	PRINTED CIRCUIT BOARD A-2, Part No. 79-140				
A2-C1	CAPACITOR: 150 PF, 500V	24-044	5R5T15	93790	
A2-C2	CAPACITOR: 150 PF, 500V	24-044	5R5T15	93790	
A2-C3	CAPACITOR: 100 UF, 25V	24-2279-14	TE1211	56289	
A2-C4	CAPACITOR: 500 UF, 25 VDC	24-2555-3	45D10095	56289	
A2-CR1	DIODE: Zener, 6.2V, ±5 , 400 MW	26-249	1N823	04713	
A2-CR2	RECTIFIER: 100V, 375MA	26-158-1	CER68	11961	
A2-CR3	RECTIFIER: 100V, 375MA	26-158-1	CER68	11961	
A2-CR4	RECTIFIER: 100V, 375MA	26-158-1	CER68	11961	
A2-CR5	RECTIFIER: 100V, 375MA	26-158-1	CER68	11961	
A2-CR6	DIODE: Zener, 10V, ±5 , 400 MW	26-247	1N758A	04713	
A2-CR7	DIODE: Zener, 4.7V, ±5 , 400 MW	26-211	1N750A	04713	
A2-OP	AMPLIFIER, Operational	18-601	MC1709CG	04713	
A2-Q1	TRANSISTOR: Silicon, PNP	18-194	2N2905	01295	
A2-Q2	TRANSISTOR: Silicon, NPN	18-193	2N2219A	04713	
A2-Q3	TRANSISTOR: Silicon, NPN	18-193	2N2219A	04713	

GENERAL INFORMATION

WARRANTY

Raytheon warrants all parts of equipment of its manufacture, except special purpose tubes and semiconductor devices which carry their own manufacturer's warranty, to be free from defects caused by faulty material or poor workmanship. Raytheon warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgment form to be free from defects caused by faulty material or poor workmanship. Raytheon's obligation is limited under the warranty to repair or replacement of products in kind, or at its sole option to issuance of a credit of original purchase price. Returns must be accompanied by a Raytheon Return Authorization form and conform to standard conditions for adjustment. The aforesaid warranty shall expire twelve (12) months following the last day of the month of shipment from Raytheon's plant. The foregoing states the entire warranty extended by Raytheon. No other warranty, express or implied, is made and, specifically, Raytheon makes no warranty of merchantability or fitness for any purpose. In no case shall Raytheon be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

RAYTHEON COMPANY, Sorensen Operation

SERVICE INFORMATION

Questions concerned with the operation, repair, or servicing of this instrument should be directed to the nearest Sorensen representative (a list is included with this manual) or to the Service Department, Raytheon Company, Sorensen Operation, Richards Avenue, South Norwalk, Connecticut. *Include the model number and serial number,* in any correspondence concerning this instrument.

SHIPPING DAMAGE

It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be tested and inspected as soon as it is received. If the instrument shows signs of damage, follow the instructions on the DAMAGE and/or Loss in Shipment form enclosed with the unit and notify the carrier immediately. The carrier's claim agent will then prepare a report of damage and, after you have forwarded this to the Sorensen Service Department, you will be advised as to the action necessary to have the instrument repaired or replaced.

RETURNS TO THE FACTORY

Should it be necessary to return an instrument to the factory for repair, please contact the Sorensen Service Department for authorization to make shipment.

RAYTHEON COMPANY WILL ASSUME NO RESPONSIBILITY FOR MATERIAL RETURNED WITHOUT PRIOR AUTHORIZATION.

MP MASTER
MA25509

RAYTHEON
Raytheon Company
Richards Avenue, Nor
Tel: 203-838-6571; TWX

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